

# Best Ever Alarm System Toolkit

**BEAST**

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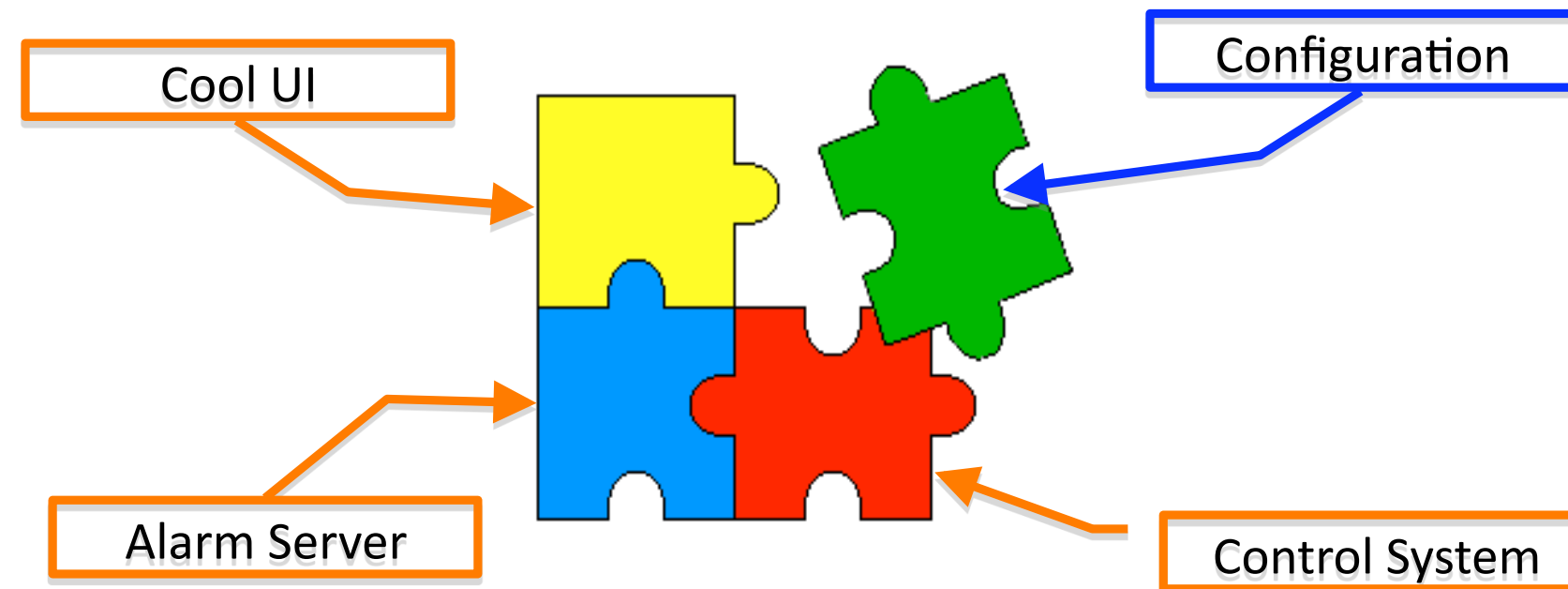
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Epics Meeting 2010 Fall

# Alarm System Components



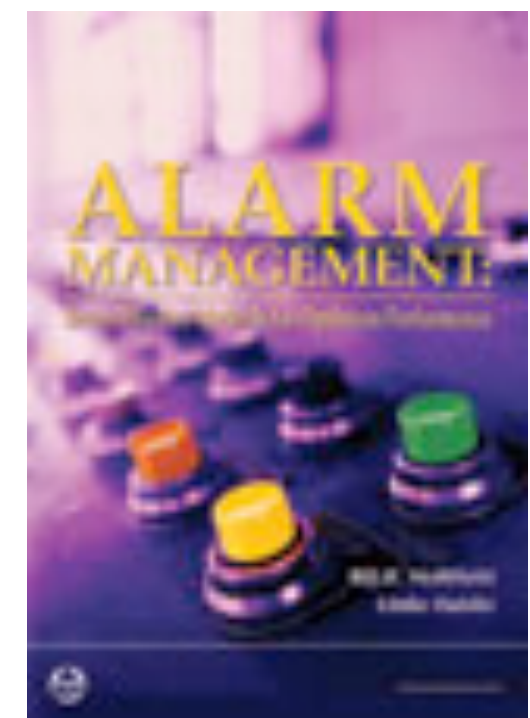
## This talk: Alarm System Technology

### See also:

B. Hollifield, E. Habibi, "Alarm Management: Seven Effective Methods for Optimum Performance", ISA, 2007

"SNS Alarms Philosophy" (Printout available)

Alarm Rationalization: Practical Experience Rationalizing Alarm Configuration for an Accelerator SubSystem, Xiaosong Geng, etc.,  
<http://info.ornl.gov/sites/publications/files/Pub22522.PDF>



# Previous Attempts at SNS, Inspiration

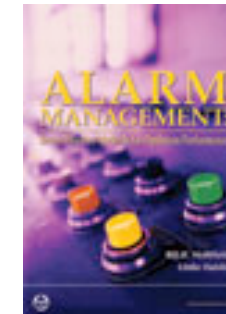
## EPICS “ALH”, Generated soft-IOCs and EDM screens

- Old technology
- Static UI layout
- N clicks to see (some of the) active alarms
- **Configuration** changes were hard (so config. was left in bad shape)

## DESY Alarm System

*Matthias Clausen, “Alarm Management System”, PCaPAC, Oct 2008, Slovenia and “Managing Alarms ... the CSS Way”, this conference*

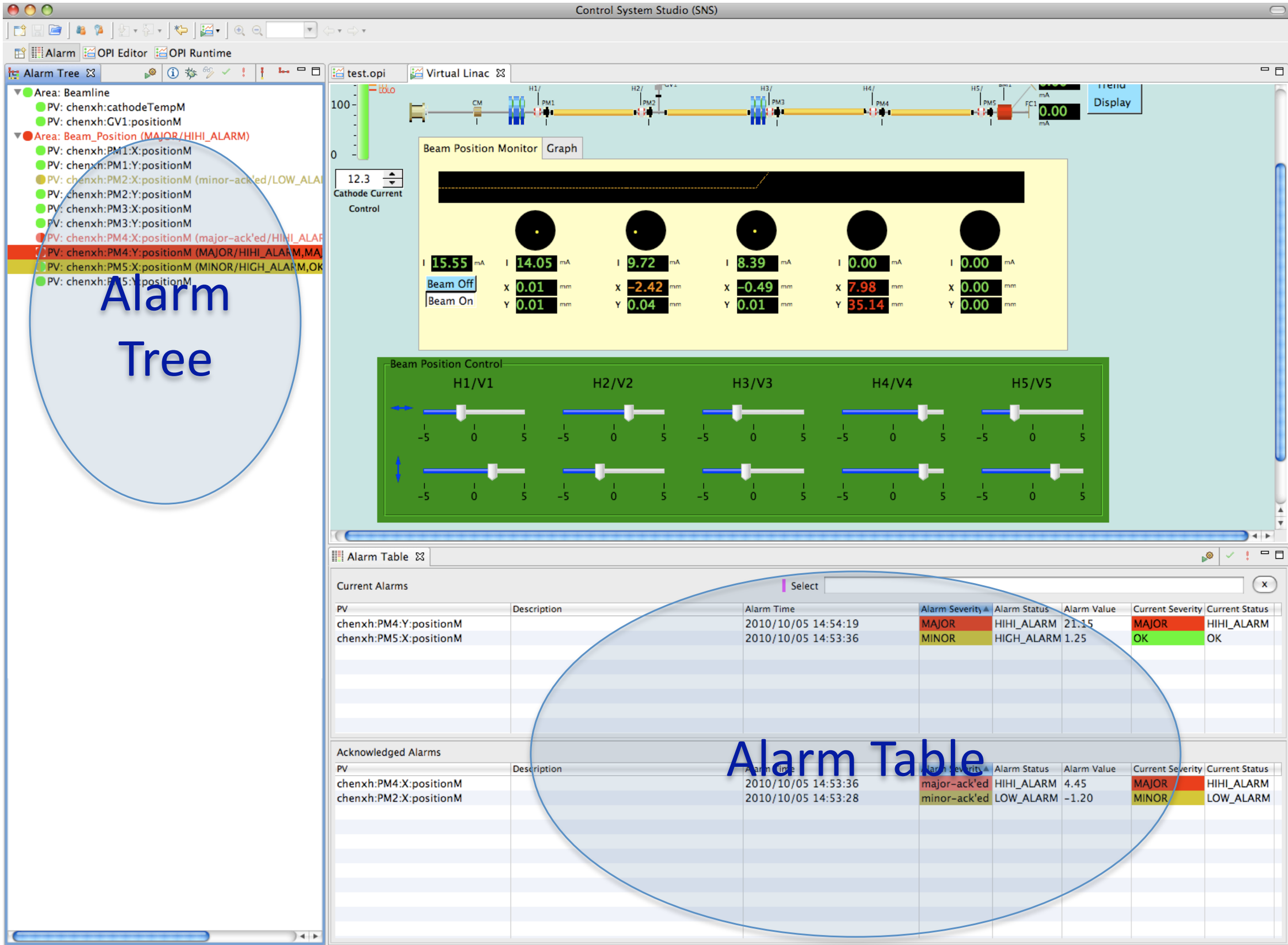
- ✓ Modern technology, linked into Control System Studio
- Different infrastructure: LDAP vs. RDB
- How does a PV turn into an alarm?



## Ideas from “Alarm Management: ...” book

- Need multiple views of alarms
- Alarms must have guidance, links to related displays
- Need tools to monitor alarm rate, stale alarms, ...  
to continually improve **configuration**

# New End-User View



# New End-User View: Alarm Table

Acknowledge one or multiple alarms

- Select by PV or description
- BNL/RHIC type un-ack'

Sort by column

All current alarms

- active
- ack'ed

Optional:  
Voice Annunciation



The screenshot shows a software window titled "Alarm Table" with two main sections: "Current Alarms" and "Acknowledged Alarms".

**Current Alarms Section:**

PV	Description	Time	Current Seve	Severity	Status	Value
ICS_MPS:FPAR_CCL_BS:FP	* mps fault	2009/04/15 16:22:50	MAJOR	MAJOR	LINK_ALARM	0
CF_KL:DIWS_AIT4306B:Rs	Check polishing loop resistivity for KL4	2009/04/15 15:50:58	OK	MINOR	HIGH_ALAR	2.5

**Acknowledged Alarms Section:**

PV	Description	Time	Current Seve	Severity	Status	Value
TMod:Summary_MPS:Alarm	Moderator System MPS Trip or PLC	2009/04/13 08:19:02	INVALID	invalid-ack'ed	READ_ALAR	Ready
HEBT_Coll:CT2:Cond	Hebbit collimator outlet flow conduct	2009/04/13 08:19:02	MAJOR	major-ack'ed	LOLO_ALAR	0.016

Annotations with orange arrows:

- "All current alarms" points to the "Current Alarms" section header.
- "active" points to the "MAJOR" status in the first row of the "Current Alarms" table.
- "ack'ed" points to the "invalid-ack'ed" status in the first row of the "Acknowledged Alarms" table.
- "Optional: Voice Annunciation" points to the speaker icon in the bottom right corner of the window.
- "Sort by column" points to the "Select" dropdown menu in the "Current Alarms" section.
- "Acknowledge one or multiple alarms" points to the "x" button in the "Select" dropdown menu.
- "Select by PV or description" points to the text input field in the "Select" dropdown menu.
- "BNL/RHIC type un-ack'" points to the "MAJOR" status in the first row of the "Current Alarms" table.



# Another View: Alarm Tree

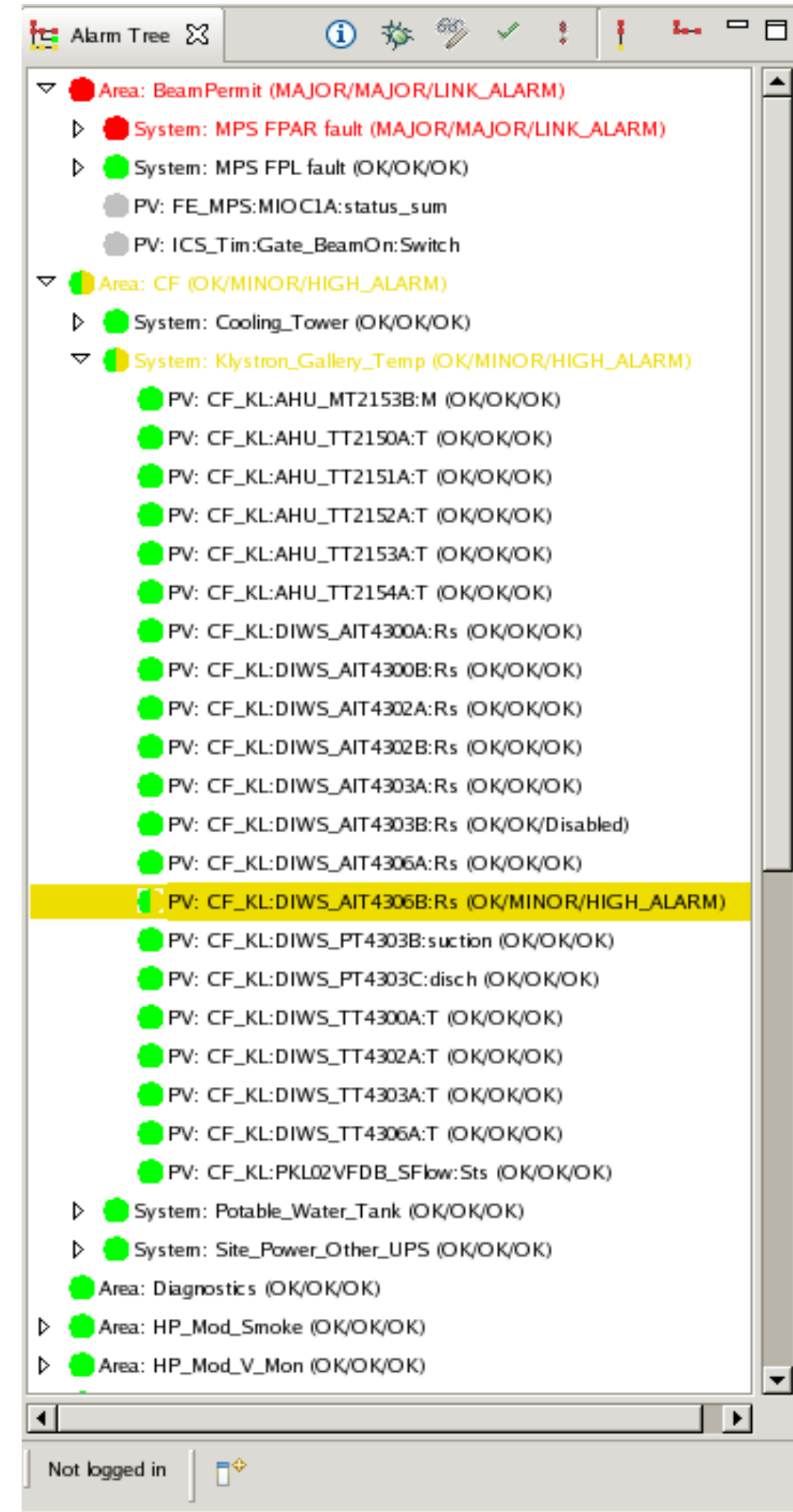
## See complete configuration

- Active, ack'ed, inactive, disabled

## Hierarchical

- Optionally only show active alarms
- Ack'/Un-ack' PVs or sub-tree

Users choose to display  
table and/or tree



# Guidance, Related Displays Commands

**Alarm Tree**

- Area: BeamPermit (OK/OK/OK)
- Area: CF (OK/MINOR/HIGH\_ALARM)
  - System: Cooling\_Tower (OK/OK/OK)
    - System: Cooling\_Tower\_Fans (OK/OK/OK)
    - System: Cooling\_Tower\_Pumps (OK/OK/OK)
    - PV: CF\_CU:TWR2\_TW\_Trouble:Sts (OK/OK/OK)
    - PV: CF\_CU:TWR\_FT4017:Flw (OK/OK/OK)
    - PV: CF\_CU:TWR\_TT4016:T (OK/OK/OK)
    - PV: CF\_CU:TWR\_TT4017:T (OK/OK/OK)
    - PV: CF\_CU:TWR\_TT4018:T (OK/OK/OK)
  - System: Klystron\_Gallery\_Temp (OK/OK/OK)
  - System: Potable\_Water\_Tank (OK/OK/OK)
  - System: Site\_Power\_Other\_UPS (OK/OK/OK)
- Area: Diagnostics (OK/OK/OK)
- Area: HP\_Mod\_Smoke (OK/OK/OK)
- Area: HP\_Mod\_V\_Mon (OK/OK/OK)
- Area: HPRF\_PLC\_Check (OK/OK/OK)
- Area: HPRF\_Rack\_Sts (OK/OK/OK)
- Area: ICS (OK/OK/OK)
- Area: MPS (OK/OK/OK)
- Area: PPS (OK/OK/OK)
- Area: Timing (OK/OK/OK)
- Area: Tunnels (OK/OK/OK)
- Area: Water\_Pump (OK/OK/OK)
- Area: IonSource (OK/OK/OK)

**Properties**

**Alarm PV: CF\_CU:TWR2\_TW\_Trouble:Sts**

**Purpose of Alarm**

Indicates insufficient tower water problem, either flow or elevated temperature or pump failure.

Flow (5500gpm) and temperature limits are fixed in the PLC. For changes see contacts listed below.

**Operator Guidance**

Look at tower water pump screen. There should be 3 pumps running. If not, attempt turn-on via operator screen.

If that fails, turn them on manually at CUB. If all fails, call contacts listed below.

**Failure Consequence**

MAJOR consequence: Beam will be off for 12 hours, cold box will trip, ...

TODO: List the top 3 critical items and response times in each case to avoid shutdown.

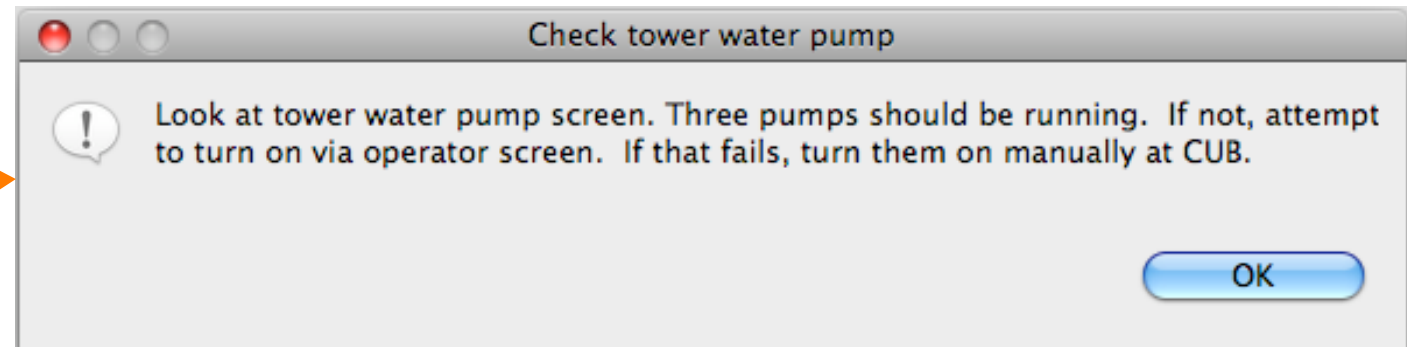
**Operator Response Time Available**

Usually less than 5 minutes in order to prevent further temperature increase.

TODO: Response time depends on beam power. How should this be factored into response?

**Contacts**

Water System Mechanical Engineers: Greg Irby, Jerry Ferguson Control System Contact: Frank Brantley



- ✓ View Guidance Texts
- ✓ Start related displays (EDM)
- ✓ Open Web pages
- ✓ Run ext. commands

**Hierarchical:**  
Including info of parent entries

**Merges Guidance etc. from all selected alarms**

# CSS Integration: Alarm → Data Browser

1. Context menu: Alarm Duration, Guidance, Displays, ...
2. Select Data Browser for PV in alarm
3. View history, annotate

**Alarm Tree**

- Area: BeamPermit (MAJOR/major-ack'ed/LOLO\_ALARM)
  - PV: FE\_MPS:MIOC1A:status\_sum (MAJOR/major-ack'ed/LOLO\_ALARM)
  - PV: ICS\_Tim:Gate\_BeamOn:Switch (MINOR/minor-ack'ed/LOLO\_ALARM)
- Area: CF (MINOR/MINOR/HIGH\_ALARM)
- Area: Diagnostics (OK/OK/OK)
- Area: HP\_Mod\_Smoke (OK/OK/OK)
- Area: HP\_Mod\_V\_Mon (OK/OK/OK)
- Area: HPRF\_PLC\_Check (OK/OK/OK)
- Area: HPRF\_Rack\_Sts (OK/OK/OK)
- Area: ICS (OK/OK/OK)
- Area: MPS (OK/OK/OK)
- Area: PPS (OK/OK/OK)
- Area: Timing (OK/OK/OK)
- Area: Tunnels (OK/OK/OK)
- Area: Water\_Pump (OK/OK/OK)
- Area: IonSource (OK/OK/OK)
- Area: LEBT (OK/OK/OK)
- Area: RFQ (OK/OK/OK)
- Area: MEBT (MAJOR/MAJOR/LOLO\_ALARM)
- Area: DTL (OK/OK/OK)
- Area: CCL (OK/OK/OK)
- Area: SCL (OK/OK/OK)
- Area: HEBT (MAJOR/major-ack'ed/LOLO\_ALARM)
- Area: RID (OK/OK/OK)
- Area: Ring (OK/OK/OK)
- Area: RTBT (OK/OK/OK)
- Area: Target (INVALID/invalid-ack'ed/READ\_ALARM)
- Area: Test (OK/MAJOR/HIHI\_ALARM)
  - System: LLRF (OK/OK/OK)
  - PV: Instr\_BmLn:XXSTATE5216A:Sts (OK/OK/OK)
  - PV: RFQ\_Vac:Pump2:Pressure (OK/MAJOR/HIHI\_ALARM)
  - PV: RFQ\_Vac:Pump3:Pressure (OK/MINOR/HIGH\_ALARM)
  - PV: RFQ\_Vac:Pump4:Pressure (OK/MINOR/HIGH\_ALARM)
  - PV: RFQ\_Vac:Pump5:Pressure (OK/MINOR/HIGH\_ALARM)
  - PV: RFQ\_Vac:Pump6:Pressure (OK/MINOR/HIGH\_ALARM)

**Alarm Table**

PV	Description	Time	Current Severity	Severity	Status	Value
RFQ_Vac:Pump2:Pressure	Demo pump 2	2009/03/17 16:48:10	OK	MAJOR	HIHI_ALARM	9.0
RFQ_Vac:Pump6:Pressure	Demo pump 6	2009/03/17 16:48:08	OK	MINOR	HIGH_ALARM	5.0
RFQ_Vac:Pump5:Pressure	Demo pump 5	2009/03/17 16:48:08	OK	MINOR	HIGH_ALARM	5.0
RFQ_Vac:Pump4:Pressure	Demo pump 4	2009/03/17 16:48:08	OK	MINOR	HIGH_ALARM	5.0
RFQ_Vac:Pump3:Pressure	Demo pump 3	2009/03/17 16:48:08	OK	MINOR	HIGH_ALARM	5.0
FE_MPS:MIOC1A:status_sum	MPS Beam permit	2009/03/17 16:46:28	MAJOR	MAJOR	LOLO_ALARM	2
ICS_Tim:Gate_BeamOn:Switch	Beam awf	2009/03/17 16:46:27	MINOR	MINOR	STATE_ALARM	Shift
CF_KL:DIWS_AIT4303B:Rs	CF_KL:DIWS_AIT4303B:Rs	2009/03/17 16:10:06	MINOR	MINOR	HIGH_ALARM	18.5
MEBT_CHOP:PS_2:V	mebbit chopper power supply voltage fault	2009/03/17 16:10:06	MAJOR	MAJOR	LOLO_ALARM	0.0

**Alarm Table**

PV	Description	Time
TMod:Summary_MPS:Alarm	Moderator System MPS Trip	2009/03/17 16:48:10
MEBT_CHOP:PS_1:V	mebbit chopper power supply one voltage fault	2009/03/17 16:48:08
HEBT_Coll:CT2:Cond	HEBT_Coll:CT2:Cond	2009/03/17 16:48:08

**Data Browser**

MEBT\_CHOP:PS\_2:V [kV]

Previous drop: 2009/03/15 07:02:54

Another hiccup: 2009/03/16 07:55:42

21:44:56

- Check MEBS PS 2 Chopper
- MEBT Chopper PS 2 Screen
- Logbook...
- Acknowledge
- Copy Pv Name to Clipboard
- CSS
  - Configure Item
  - Auto-size Columns
  - Alarm Perspective

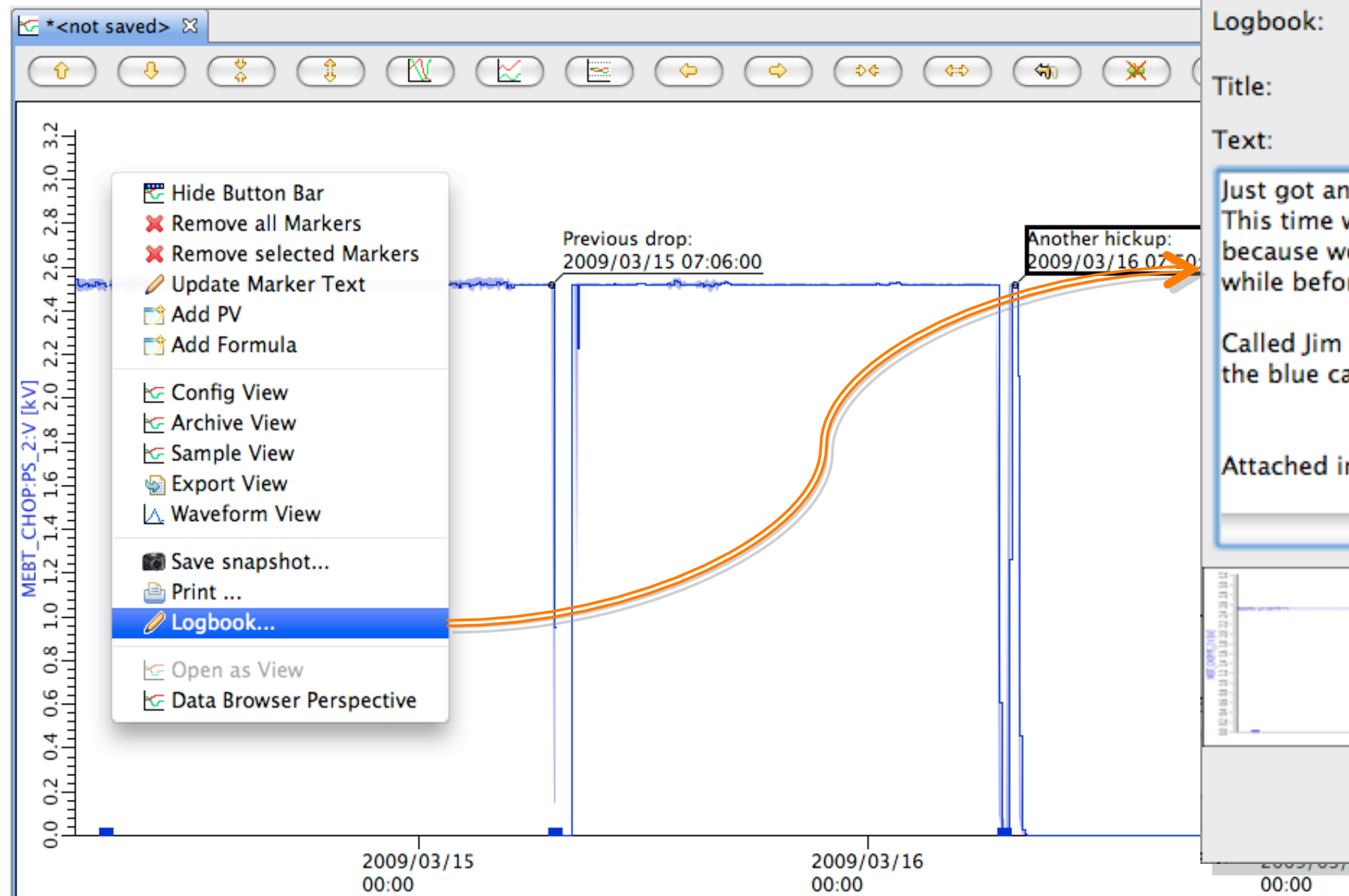
**Data Browser**

- Data Browser View
- PV Table
- Rack View
- PV Utility
- PV Fields Viewer
- Probe
- EPICS PV Tree



# Data Browser → Electronic Logbook

After inspecting alarm PV's history, post commented plot to E-Log



**Logbook Entry**

Create electronic logbook entry

Enter user, password, maybe edit text.  
Snapshot of current plot will be attached.

User name: Fred

Password: .....

Logbook: Electrical Systems

Title: Data Browser Snapshot

Text:

Just got another chopper trip.  
This time was different, though,  
because we did this and not that,  
while before we tried that and not this.

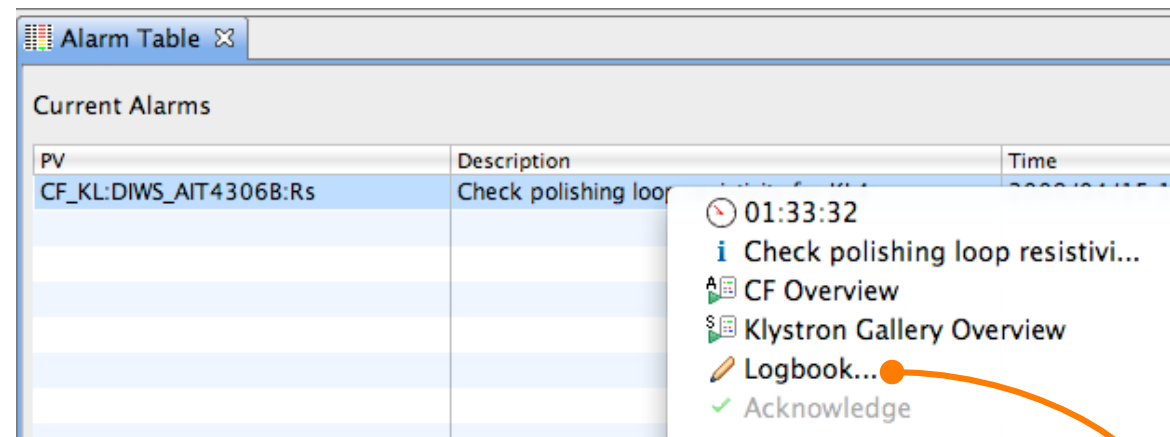
Called Jim who suggested to wiggle  
the blue cable before resetting

Attached image was created by Data Browser

Attached Image...

Cancel OK

# Directly from Alarm to E-Log



Alarm Table

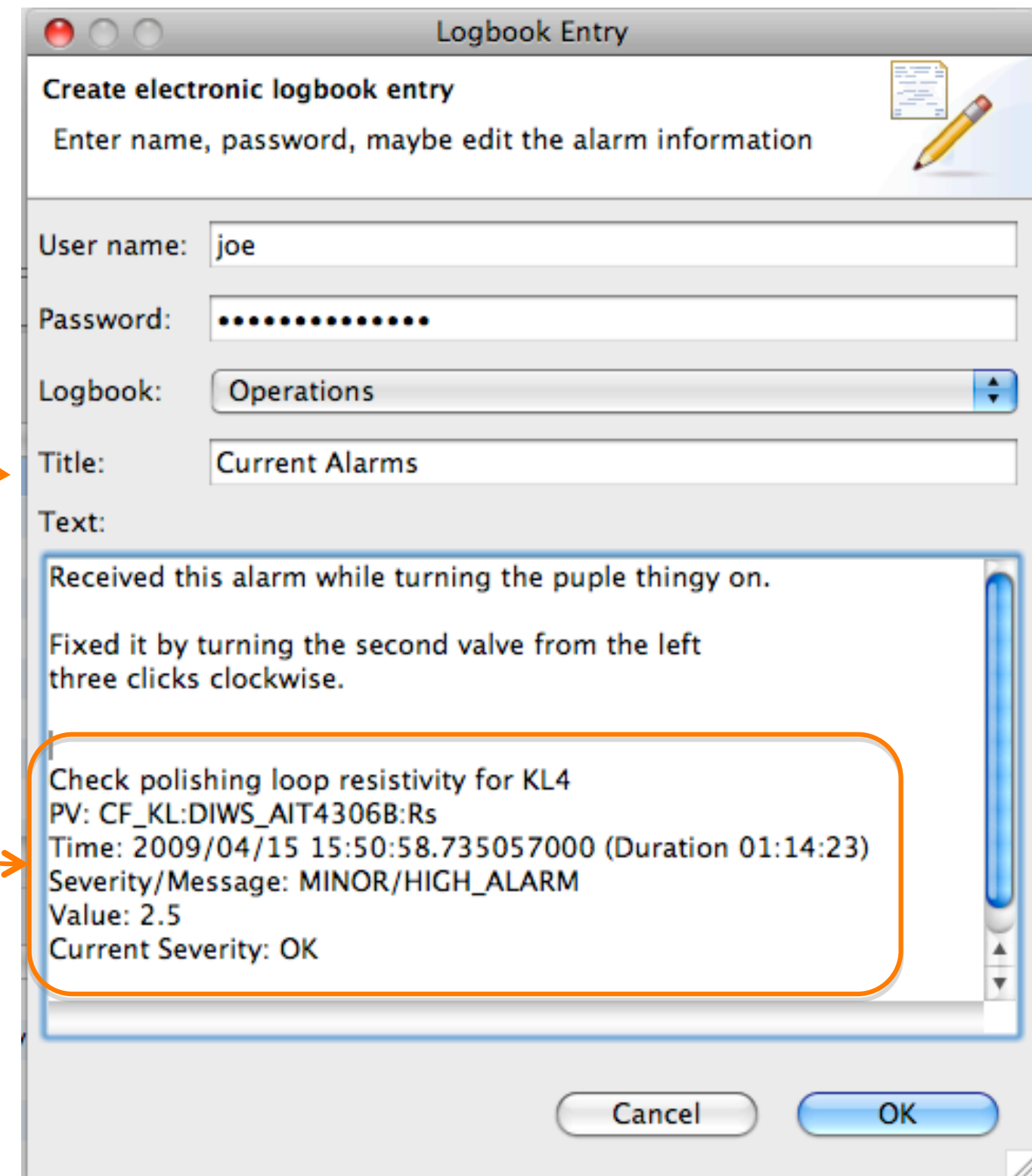
Current Alarms

PV	Description	Time
CF_KL:DIWS_AIT4306B:Rs	Check polishing loop	2009/04/15 15:50:58.735057000

Context Menu:

- 01:33:32
- Check polishing loop resistivi...
- CF Overview
- Klystron Gallery Overview
- Logbook...
- Acknowledge

- “Logbook”  
from context menu  
creates text w/  
basic info about  
selected alarms.  
Edit, submit.



Logbook Entry

Create electronic logbook entry

Enter name, password, maybe edit the alarm information

User name: joe

Password: .....

Logbook: Operations

Title: Current Alarms

Text:

Received this alarm while turning the puple thingy on.

Fixed it by turning the second valve from the left  
three clicks clockwise.

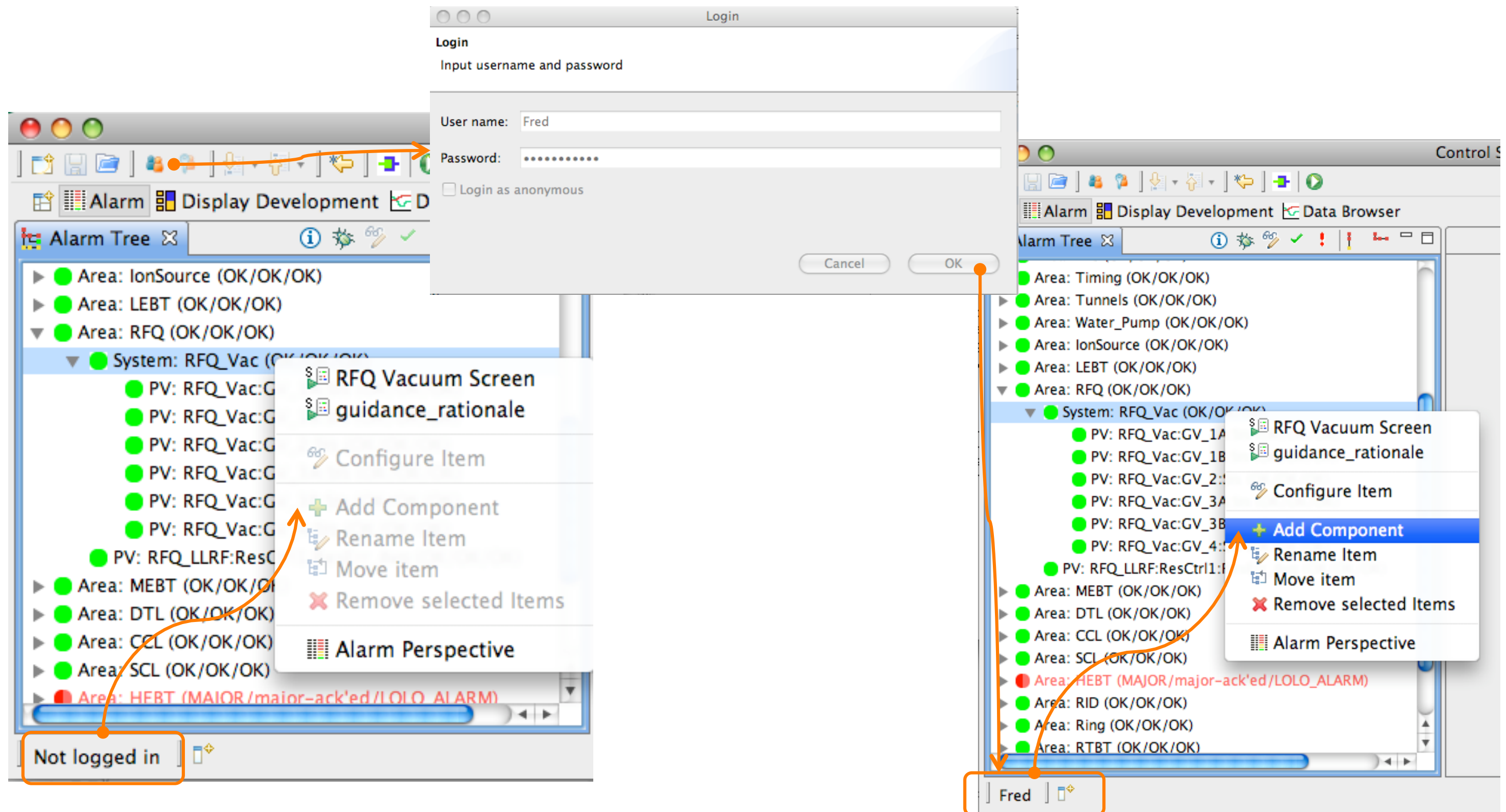
Check polishing loop resistivity for KL4  
PV: CF\_KL:DIWS\_AIT4306B:Rs  
Time: 2009/04/15 15:50:58.735057000 (Duration 01:14:23)  
Severity/Message: MINOR/HIGH\_ALARM  
Value: 2.5  
Current Severity: OK

Cancel OK

# Online Configuration Changes

.. may require Authentication/Authorization (LDAP)

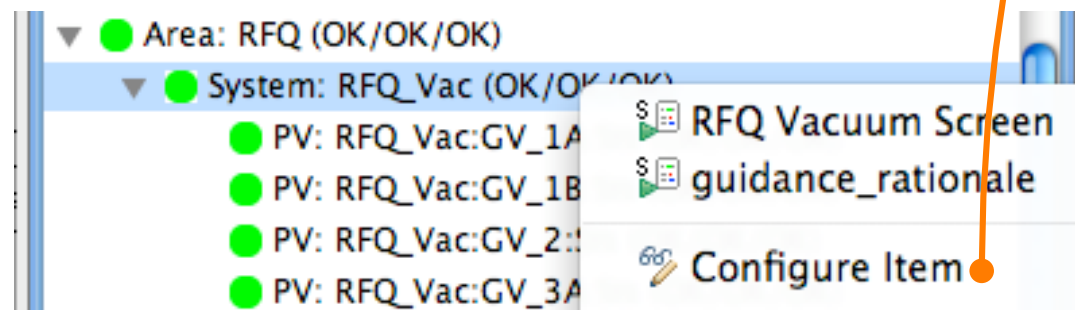
✓ Log in/out while CSS is running





# Configure PV

- Again online
- Especially useful for operators to update guidance and related screens.



for the U.S. Department of Energy

Alarm Item Configuration

Item: Annunciator/RFQ/RFQ\_LLRF:ResCtrl1:ResErr\_Avg  
Configure guidance, related displays, ...

Description: Elevated R F Q resonance error

Alarm Delay [seconds]: 0

Alarm Count [within delay]: 0

Behavior: ☒ Enabled ☐ Latch ☒ Annunciate

Enabling Filter:

Guidance:

Title	Detail
Check and fix resonance error	Check LLRF measurement of cavity residency error.
<Add>	<Add>

Displays:

Title	Command
RFQ LLRF	startedm -m S=RFQ,N=1,TN=
RFQ Chiller	startedm Cool
Rationalization	https://ics-web.sns.ornl.gov/v
<Add>	<Add>

Commands:

Title	Command
<Add>	<Add>

ID: 621 Last configured: 2009/04/14 16:46:17

Edit Row Data

Title: Check and fix resonance error

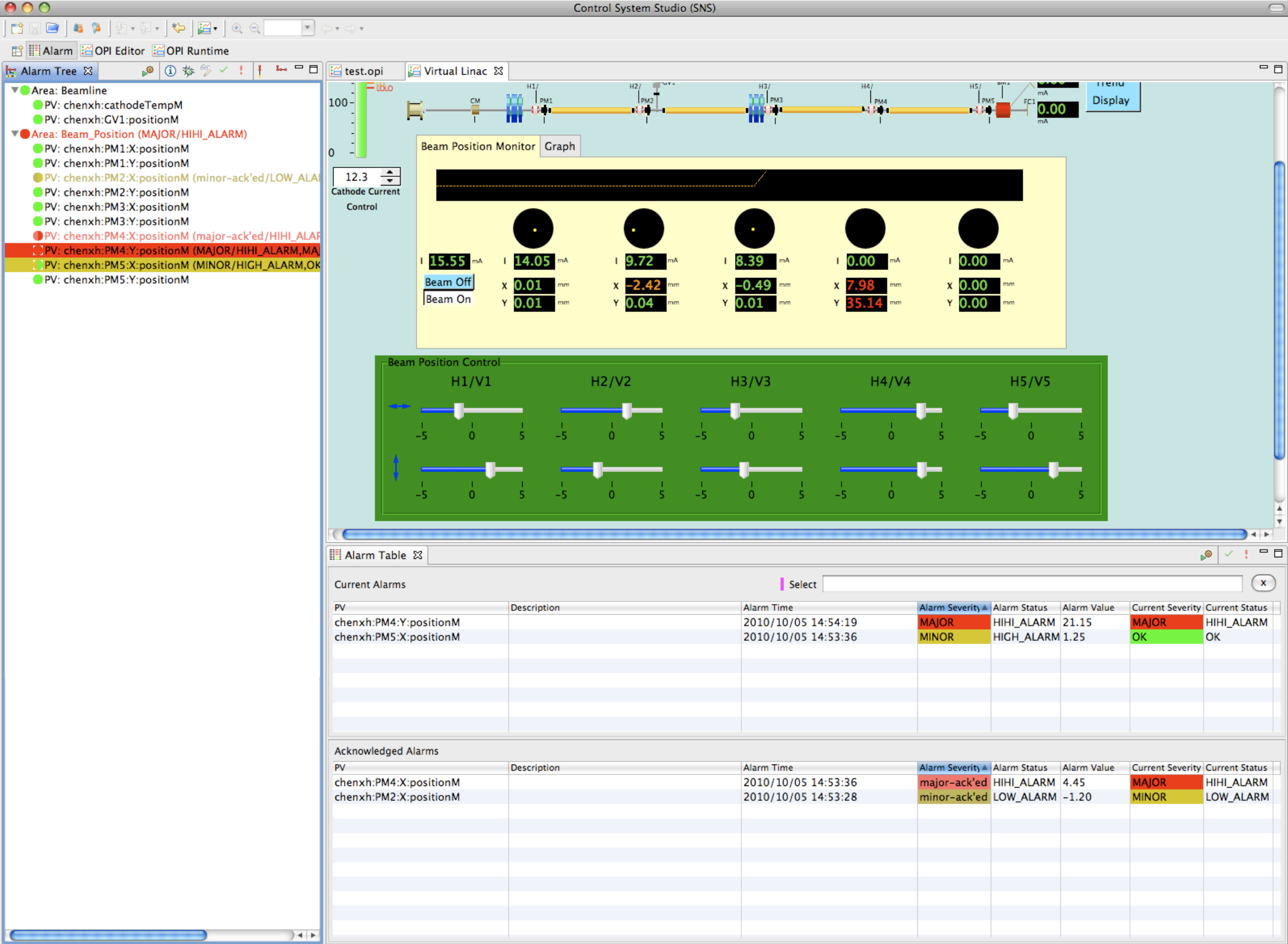
Details: Check LLRF measurement of cavity resonance error.  
Try to reduce error by adjusting LLRF pulse width as per the Daily Order.

Cancel OK

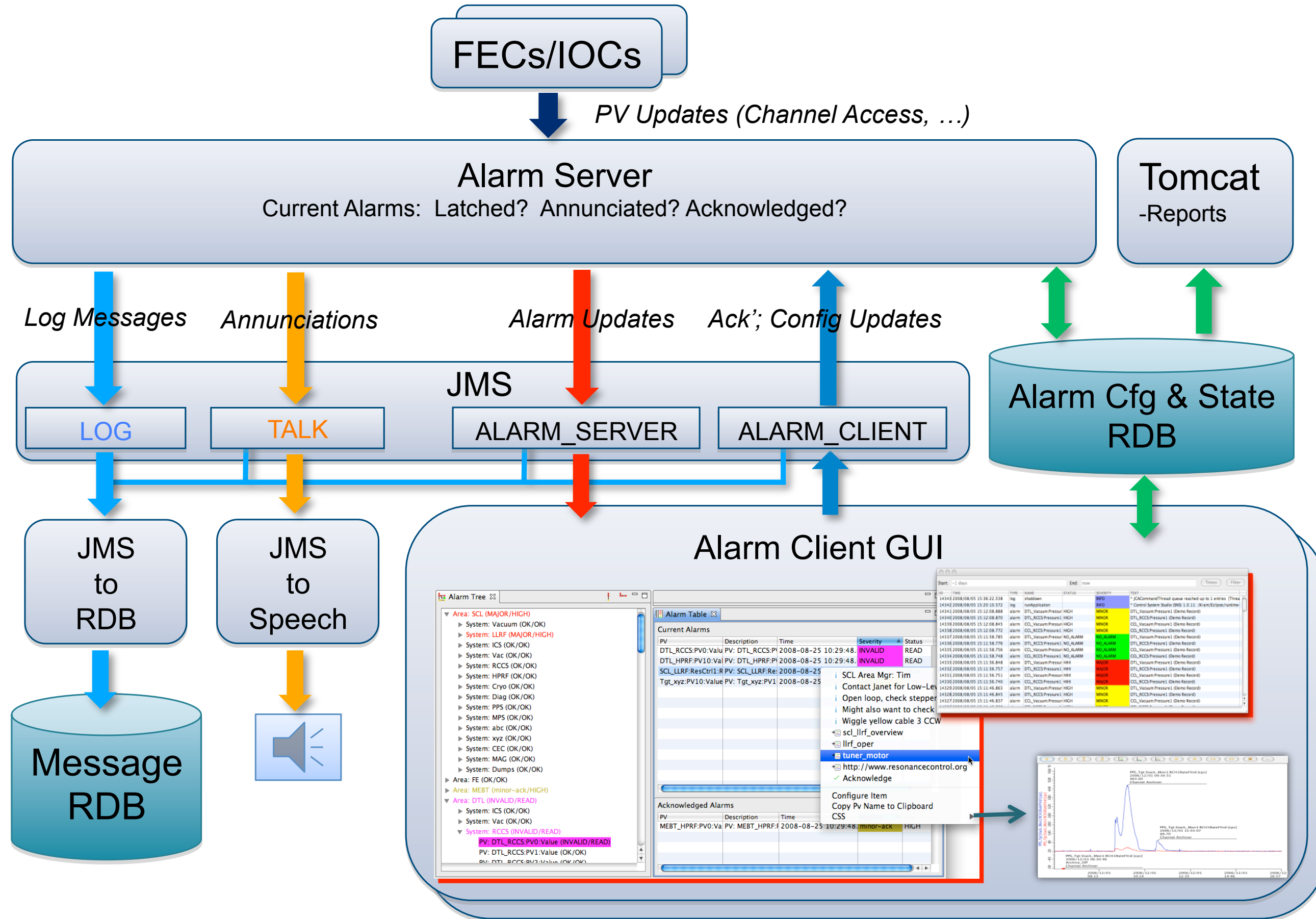


# BEAST Demo

- Virtual Linac



# Technical View

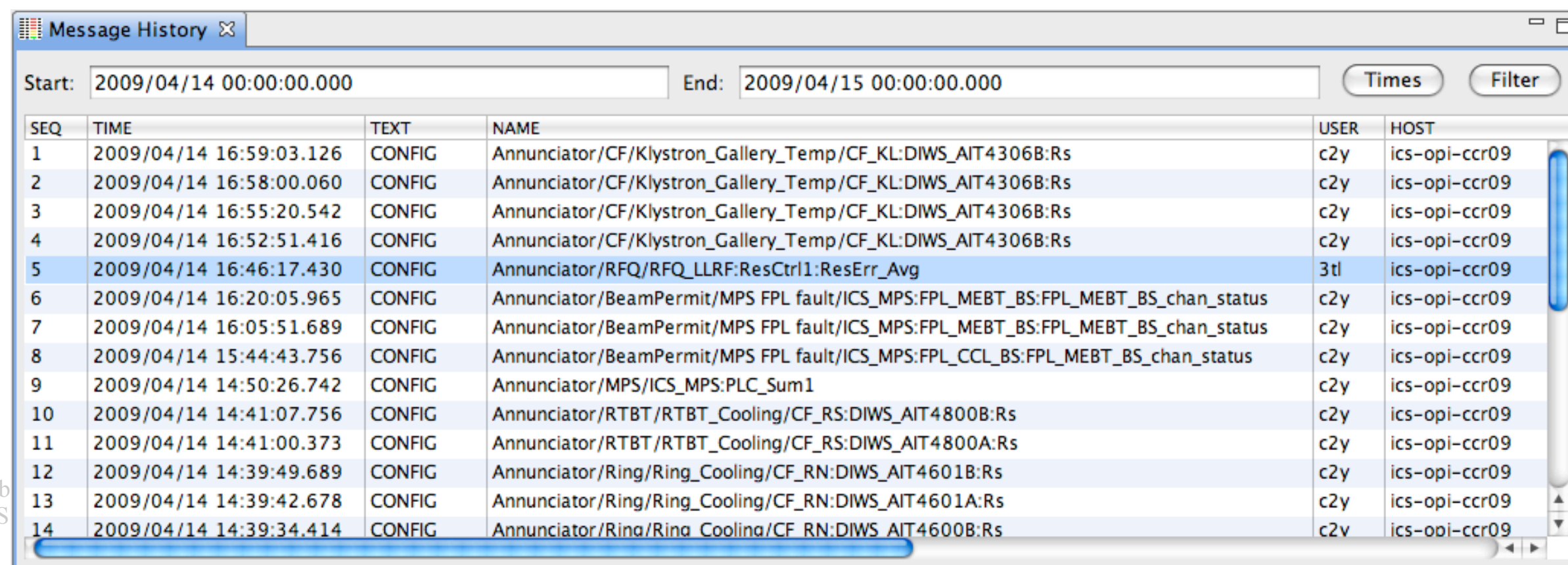


# Alarm Server Options

- Latch highest severity, require acknowledgement?
- Annunciate?
- Chatter filter
  - Alarm only if severity persists some minimum time
  - .. or alarm happens  $\geq N$  times within period
- Optional formula-based alarm enablement:
  - Enable if “(pv\_x > 5 && pv\_y < 7) || pv\_z==1”
  - ... but we prefer to move that logic into IOC
- “Maintenance Mode”: Invalid PVs don’t annunciate, automatically acknowledged

# Logging

- ..into generic CSS log also used for error/warn/info/debug messages
- Alarm Server: State transitions, Annunciations
- Alarm GUI: Ack/Un-Ack requests, Config changes
- Generic Message History Viewer
  - Example w/ Filter on TEXT=CONFIG



The screenshot shows a window titled "Message History" with a search filter set to "TEXT=CONFIG". The table displays 14 messages, all of which are configuration-related. The messages are sorted by time, from most recent at the top to oldest at the bottom. The columns are SEQ, TIME, TEXT, NAME, USER, and HOST.

SEQ	TIME	TEXT	NAME	USER	HOST
1	2009/04/14 16:59:03.126	CONFIG	Annunciator/CF/Klystron_Gallery_Temp/CF_KL:DIWS_AIT4306B:Rs	c2y	ics-opi-ccr09
2	2009/04/14 16:58:00.060	CONFIG	Annunciator/CF/Klystron_Gallery_Temp/CF_KL:DIWS_AIT4306B:Rs	c2y	ics-opi-ccr09
3	2009/04/14 16:55:20.542	CONFIG	Annunciator/CF/Klystron_Gallery_Temp/CF_KL:DIWS_AIT4306B:Rs	c2y	ics-opi-ccr09
4	2009/04/14 16:52:51.416	CONFIG	Annunciator/CF/Klystron_Gallery_Temp/CF_KL:DIWS_AIT4306B:Rs	c2y	ics-opi-ccr09
5	2009/04/14 16:46:17.430	CONFIG	Annunciator/RFQ/RFQ_LLRF:ResCtrl1:ResErr_Avg	3tl	ics-opi-ccr09
6	2009/04/14 16:20:05.965	CONFIG	Annunciator/BeamPermit/MPS FPL fault/ICS_MPS:FPL_MEBT_BS:FPL_MEBT_BS_chan_status	c2y	ics-opi-ccr09
7	2009/04/14 16:05:51.689	CONFIG	Annunciator/BeamPermit/MPS FPL fault/ICS_MPS:FPL_MEBT_BS:FPL_MEBT_BS_chan_status	c2y	ics-opi-ccr09
8	2009/04/14 15:44:43.756	CONFIG	Annunciator/BeamPermit/MPS FPL fault/ICS_MPS:FPL_CCL_BS:FPL_MEBT_BS_chan_status	c2y	ics-opi-ccr09
9	2009/04/14 14:50:26.742	CONFIG	Annunciator/MPS/ICS_MPS:PLC_Sum1	c2y	ics-opi-ccr09
10	2009/04/14 14:41:07.756	CONFIG	Annunciator/RTBT/RTBT_Cooling/CF_RS:DIWS_AIT4800B:Rs	c2y	ics-opi-ccr09
11	2009/04/14 14:41:00.373	CONFIG	Annunciator/RTBT/RTBT_Cooling/CF_RS:DIWS_AIT4800A:Rs	c2y	ics-opi-ccr09
12	2009/04/14 14:39:49.689	CONFIG	Annunciator/Ring/Ring_Cooling/CF_RN:DIWS_AIT4601B:Rs	c2y	ics-opi-ccr09
13	2009/04/14 14:39:42.678	CONFIG	Annunciator/Ring/Ring_Cooling/CF_RN:DIWS_AIT4601A:Rs	c2y	ics-opi-ccr09
14	2009/04/14 14:39:34.414	CONFIG	Annunciator/Ring/Ring_Cooling/CF_RN:DIWS_AIT4600B:Rs	c2v	ics-opi-ccr09



# Logging: Get timeline

Filter on PV

Select filter criteria:  
Which Property should contain what value?

Property: NAME Matching Value: %SCL\_HPRF:Mod15:V\_Mon%

... AND ...

Property: (no filter) Matching Value:

... AND ...

Property: (no filter) Matching Value:

... AND ...

Property: (no filter) Matching Value:

... AND ...

Property: (no filter) Matching Value:

Value patterns support SQL wildcards '%', '\_'

Cancel OK

Message History

Start: -5 day End: now

Times Filter

6. All OK

4. Problem fixed

5. Ack'ed by operator

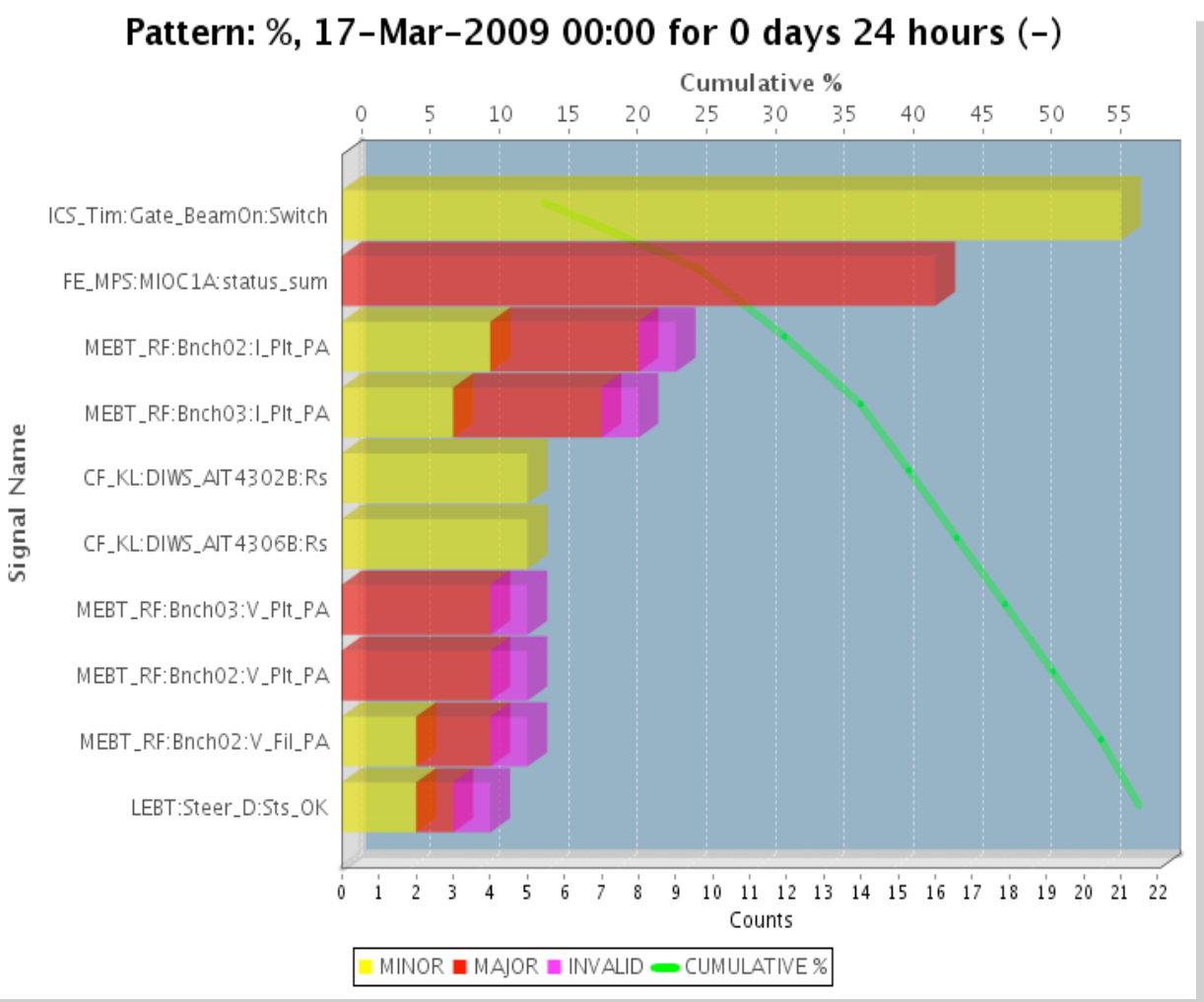
TIME	DELTA	TYPE	TEXT	NAME	STATUS	SEVERITY	CURRENT_SEVERITY	USER	APPLI...ON-ID	HOST
2009/04/12 20:30:29.522	00:00:00.039	alarm	STATE	SCL_HPRF:Mod15:V_Mon	OK	OK	OK	alarms	AlarmServer	ics-srv-sc
2009/04/12 20:30:29.483	08:16:59	alarm	ACK	SCL_HPRF:Mod15:V_Mon				accl-oper	CSS	ics-opi-co
2009/04/12 12:13:30.319	00:01:42	alarm	STATE	SCL_HPRF:Mod15:V_Mon	LOW_ALARM	MAJOR	OK	alarms	AlarmServer	ics-srv-sc
2009/04/12 12:11:47.332	01:03:08	alarm	STATE	SCL_HPRF:Mod15:V_Mon	LOW_ALARM	MAJOR	MAJOR	alarms	AlarmServer	ics-srv-sc
2009/04/12 11:08:38.729	00:02:06	alarm	STATE	SCL_HPRF:Mod15:V_Mon	LOW_ALARM	MAJOR	OK	alarms	AlarmServer	ics-srv-sc
2009/04/12 11:06:32.713	02:31:01	alarm	STATE	SCL_HPRF:Mod15:V_Mon	LOW_ALARM	MAJOR	MAJOR	alarms	AlarmServer	ics-srv-sc
2009/04/12 08:35:31.364	00:04:02	alarm	STATE	SCL_HPRF:Mod15:V_Mon	LOW_ALARM	MAJOR	OK	alarms	AlarmServer	ics-srv-sc
2009/04/12 08:31:29.283	01:15:20	alarm	STATE	SCL_HPRF:Mod15:V_Mon	LOW_ALARM	MAJOR	MAJOR	alarms	AlarmServer	ics-srv-sc
2009/04/12 07:16:09.109	00:00:00.014	alarm	STATE	SCL_HPRF:Mod15:V_Mon	OK	OK	OK	alarms	AlarmServer	ics-srv-sc

3. Alarm  
Triggered again

2. Alarm Server  
latches alarm

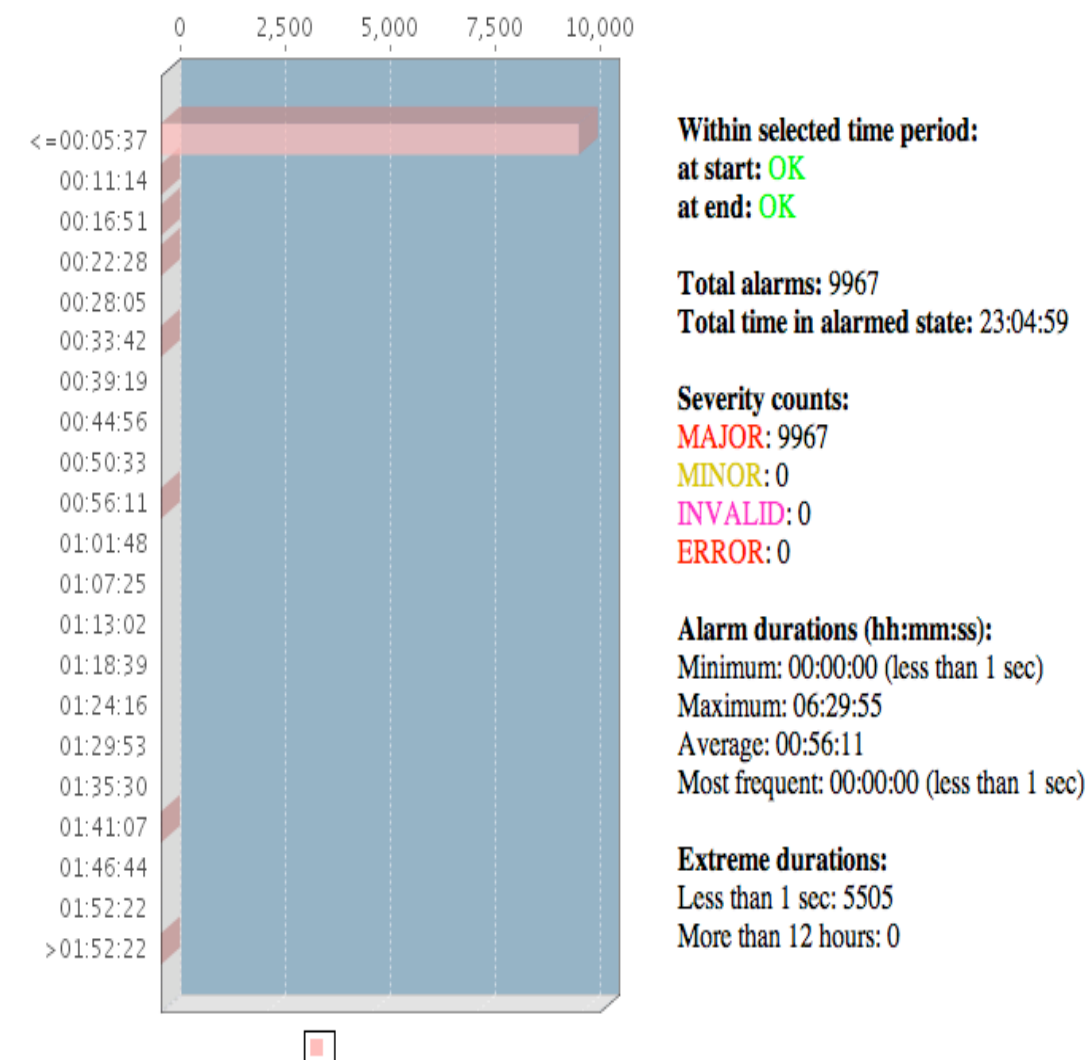
1. PV triggers,  
clears,  
triggers again

# Numerous Web Reports

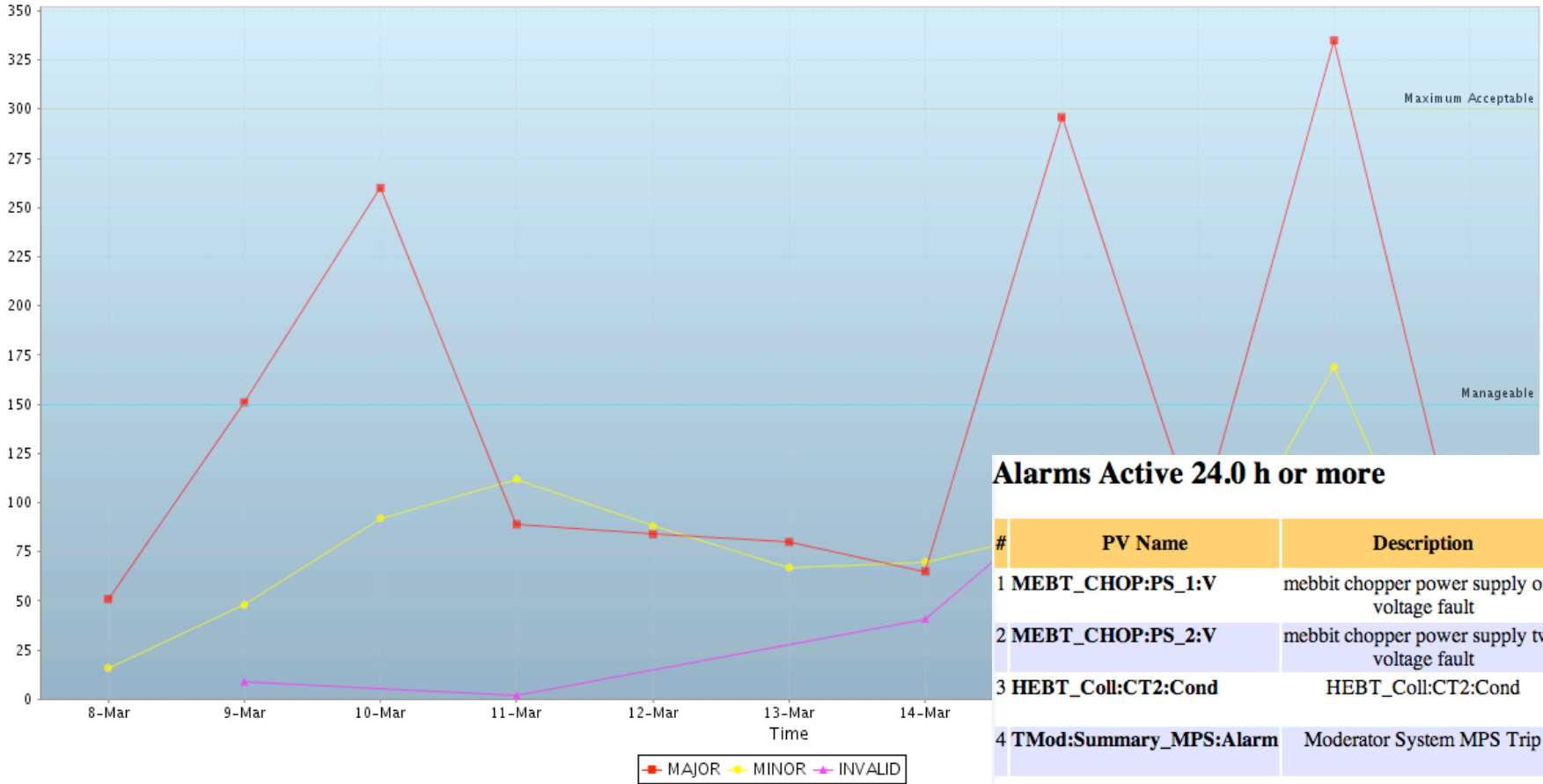


## Statistics based on CURRENT SEVERITY:

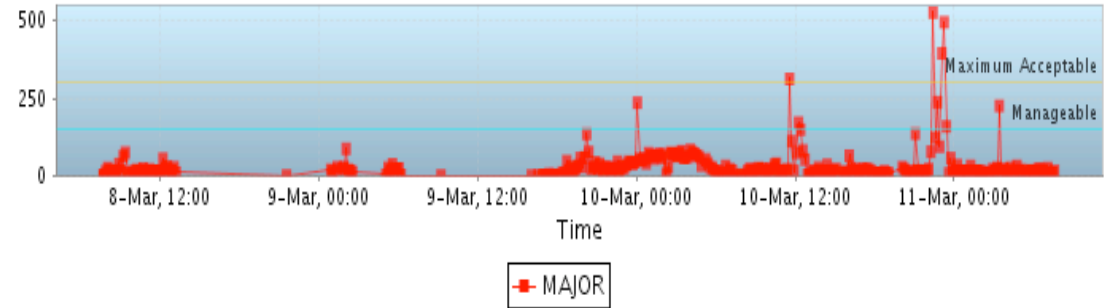
Alarms duration frequency (hh:mm:ss)



Alarms Statistics, last 10 days, pattern: %



Alarms on time line (10 min slices)



Alarms Active 24.0 h or more

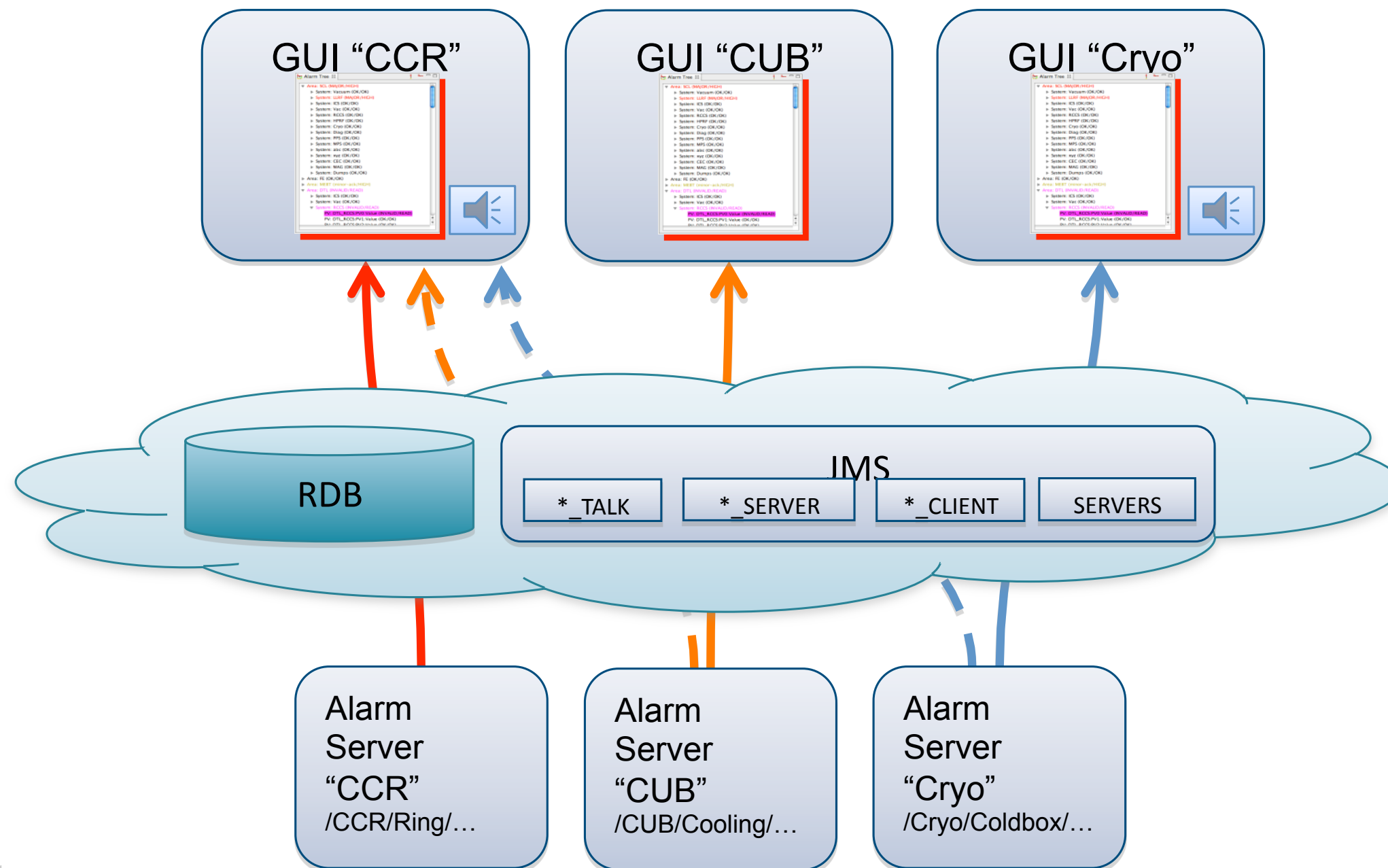
#	PV Name	Description	Path	Alarm Time	...Duration [HH:MM:SS]	Severity	Alarm Message	Current Severity
1	MEBT_CHOP:PS_1:V	mebbit chopper power supply one voltage fault	/Annunciator/MEBT	2009-03-16 13:17:35	42:58:57	MAJOR_ACK	LOLO_ALARM	MAJOR
2	MEBT_CHOP:PS_2:V	mebbit chopper power supply two voltage fault	/Annunciator/MEBT	2009-03-16 13:17:35	42:58:57	MAJOR_ACK	LOLO_ALARM	MAJOR
3	HEBT_Coll:CT2:Cond	HEBT_Coll:CT2:Cond	/Annunciator/HEBT/HEBT_Cooling	2009-03-14 20:22:50	83:53:42	INVALID_ACK	READ_ALARM	MAJOR
4	TMod:Summary_MPS:Alarm	Moderator System MPS Trip	/Annunciator/Target/CMS	2009-02-07 09:25:09	934:51:23	INVALID_ACK	READ_ALARM	INVALID

# Summary

- **Tools won't produce a good configuration, but help to improve it**
  - Most frequent alarms?
  - Alarm 'noise'?
- **BEAST operational at SNS since Feb'09**
  - Started with previous ALH setup
    - ~300, no guidance, no related displays
    - Now ~400, all with guidance, rel. displays, links to operational procedures
  - Alarm Server stable through IOC reboots, online configuration changes, Oracle updates
- **Alarm GUI is 'best ever' for SNS**

# Future of BEAST

- Auto Dialer, Phone System
- Better support for multiple setups





# Thank You!

- **BEAST Home Page:**
  - <http://sourceforge.net/apps/trac/cs-studio/wiki/BEAST>
- **Setup Instruction**
  - No downloadable alarm server available. Need to build your own from CSS source repository.
  - <https://ics-web.sns.ornl.gov/css/docs/BEAST.doc>

